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54 Insert for liquid phase diffusion bonding.

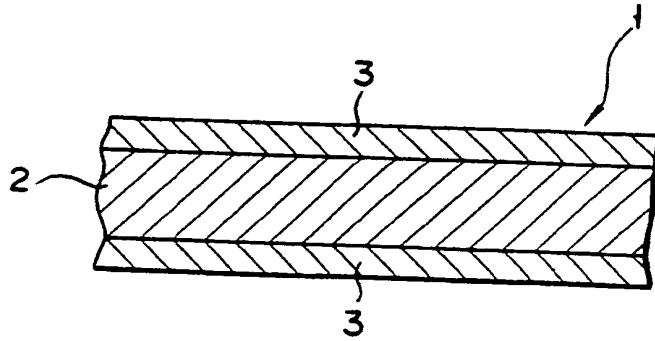
57 Insert I comprises thin substrate (2) made by cold-rolling, and two bonding alloy layers (3) formed by plating on the upper and lower surfaces of substrate (2), respectively. Both layers (3) are extremely thin, and are made of an alloy having a melting point lower than that of substrate (2). Insert(I) is used to

achieve liquid phase diffusion bonding of first and second base metals (4, 5). Insert(I) is interposed between first base metal (4) and second base metal (5). Then, insert (I) and base metals (4, 5) are clamped together with a pressure of, for example, 50 bar, and are placed in an atmosphere of a low

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pressure of about 10^{-4} Torr and heated to the melting point of alloy layers (3) or to a temperature above this melting point but below the melting points of substrate and plates (4, 5).

FIG. 1



Insert for liquid phase diffusion bonding

The present invention relates to an insert which is to be interposed between two base metals for achieving liquid phase diffusion bonding of these base metals.

In order to join the base metals such as high-alloy which are difficult to apply fusion-weld techniques, or in order to join base metals which have large joining interface, the method called "diffusion bonding" is employed. This method consists in first holding two base metals to be bonded together by proper means and then heating them in vacuum or an inert-gas atmosphere, thereby diffusing metal atoms from one base metal into the other, or from an insert to one or both base metals, and thus bonding the base metals together without melting the base metals. Various methods of diffusion bondings are known. They are classified into three types, direct diffusion bonding, solid phase diffusion bonding, and liquid phase diffusion bonding.

In direct diffusion bonding, two base metals are held in face-to-face contact. In solid phase diffusion bonding, an insert is interposed between two base metals and metal atoms diffuse from the insert into the base metals without melting the insert. In liquid phase diffusion bonding, an insert is interposed between two base metals and is melted, whereby metal atoms diffuse from the insert into the base metals. Liquid phase diffusion bonding is advantageous over the other two diffusion bonding methods in that a lower pressure is required to hold the base metals and/or the insert together.

The insert used in the liquid phase diffusion bonding is made of a metal or an alloy having a melting point lower than that of the base metal. The assembly consisting of the base metals and the insert interposed between the base metals is heated in vacuum or an inert-gas atmosphere to the melting point of the insert or a higher temperature, thereby melting the insert. As the insert melts, the metal atoms diffuse from the insert into the base metals, whereby the base metals are bonded. (See U.S. Patent 3,678,570 to Paulonis et al.) It is desirable that the insert be thin enough, 5 to 200 μm , to allow the metal atoms to diffuse easily into the base metals. Two types of such thin inserts are available. The first type is a film made of powder of insert material or a foil of insert material. The second is an insert made of one or two layers of insert material formed on the joining surfaces of the base metals, respectively, either by plating or by spraying.

When the insert used in the liquid phase diffusion bonding is a film made of powder of insert material or consists of one or two layers of insert material formed on the base metals by spraying,

respectively, an oxide is likely to be formed on the joining surfaces of the base metals. Further, since it is difficult to make such an insert have a uniform thickness, some portions of the insert will remain on the joining surfaces of the base metals after the base metals have been heated. For these reasons, the bonding strength attained is insufficient. On the other hand, the insert, which consists of one or two layers of insert material plated on the base metals, can have a uniform thickness if the base metals have simple shapes. If these base metals are large, or have complicated shapes, the insert can hardly have a uniform thickness.

On the other hand, it is relatively easy to form a foil of insert material, having a uniform thickness. This foil can therefore provide an insert layer having a uniform thickness for large joining surfaces. The foil can be made either by rolling or by rapid solidification process. One of the alloys that can be rolled into a foil having 5 to 200 μm is Al-13% Si alloy. This alloy is usually used in component of a so-called brazing sheet. The brazing sheet is made first by sandwiching a thin aluminum plate between two thin plates of Al-13% Si alloy and then by rolling all these plates together. As is disclosed in Japanese Patent Disclosure No. 119683 (1981) KOKAI, the brazing sheet is interposed between a Ti plate and an Al plate, or between two Al plates, thus to join these plates by liquid phase diffusion bonding.

To fasten two base metals of Ni-based alloy by liquid phase diffusion bonding, an insert made of a Ni-based alloy containing P, B or Si which lowers the melting point of the Ni-based alloy, is after used. This alloy and the other low melting-point alloys forming inserts for liquid phase diffusion bonding can hardly be rolled into foils having a thickness of 5 to 200 μm . This is because all these alloys has a small workability and the foils made by hot-rolling these metals are apt to have cracks. Indeed rapid solidification process can provide thin foils made of these alloys and having a thickness of 5 to 200 μm , but cannot provide thin foils having a size of 1 m (length) \times 0.5 m (width) or a wider size. Most of the low melting-point alloys, generally used as the materials of inserts for liquid phase diffusion bonding, are brittle. A thin foil made of any of these alloys and interposed between two base metals will be apt to be torn when the base metals slide against each other. In some cases, the thin foil can be torn while it is inserted into the gap between the base metals.

Accordingly, the object of the present invention is to provide an insert for liquid phase diffusion bonding, which can bond base metals, even if the

base metals are large and/or have a complicated shape, and which is easy to manufacture and to handle.

An insert according to one aspect of the invention is to be inserted between a first base metal and a second base metal, both made of a metal or an alloy, to join the first and second base metals by liquid phase diffusion bonding. This insert comprises a thin substrate and two bonding alloy layers plated on both surfaces of the substrate, respectively. The substrate is made of a material selected from the group consisting of Fe, Ni, Cu, Ti, a Fe-based alloy, a Ni-based alloy, a Cu-based alloy and a Ti-based alloy. Either bonding alloy layer has a melting point lower than that of the first and second base metals. When the insert is interposed between the first and second base metals, and the insert and both base metals are then heated to the melting point of the alloy layers or to a higher temperature, the atoms of the alloy layers diffuse into the first and second base metals, and also into the substrate, whereby the substrate joins these base metals.

An insert according to another aspect of the invention is to be inserted between a first base metal and a second base metal, both made of a metal or an alloy, to join the first and second base metals by liquid phase diffusion bonding. This insert comprises a thin substrate and one bonding alloy layer plated on one surface of the substrate. The substrate is the same material as the first base metal or a material containing the main element of the first base metal. This material is selected from the group consisting of Fe, Ni, Cu, Ti, a Fe-based alloy, a Ni-based alloy, a Cu-based alloy and a Ti-based alloy. The bonding alloy layer has a melting point lower than that of the substrate and that of the first and second base metals. The insert is interposed between the first and second base metals with the bonding alloy layer contacting the second base metal, and the insert and both base metals are then gradually heated. When the bonding alloy layer is heated to its melting point or a higher temperature, its atoms diffuse into the second base metal. At the same time the bonding alloy layer is heated, the substrate is joined to the first base metal by direct diffusion bonding. As a result, the insert join the first and second bodies by liquid phase diffusion bonding.

As has been described, in either insert of the invention, the bonding alloy layer or layers are plated on the substrate made of a material selected from the group consisting of Fe, Ni, Cu, Ti, a Fe-based alloy, a Ni-based alloy, a Cu-based alloy and a Ti-based alloy. The alloy layers can, therefore, have a uniform thickness even if the first and second bodies are large and/or have a complicated shape uneven. It follows that these alloy layers can

strongly and firmly join the base metals together. Since the substrate is made of a mechanically strong material, the insert is easy to manufacture and handle. Further, since the bonding alloy layers are formed by plating, they can be extremely thin. Hence, they can be heated to their melting point or a higher temperature in a short period of time.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a cross-sectional view of an insert according to the present invention;

Fig. 2 is a cross-sectional view of two base metals joined by the insert of Fig. 1 interposed between the base metals;

Fig. 3 is a cross-sectional view of another insert according to the invention; and

Fig. 4 is a cross-sectional view of two base metals joined by the insert of Fig. 3 interposed between the base metals.

The embodiments of the present invention will now be described in detail, with reference to the accompanying drawings.

Fig. 1 is a cross-sectional view of insert 1 according to a first embodiment of the invention. Fig. 2 shows two base metals 4 and 5 joined by an insert 1 interposed between them. As is shown in Fig. 1, insert 1 comprises a thin substrate 2 made by cold-rolling, and two bonding alloy layers 3 formed by plating on the upper and lower surfaces of substrate 2, respectively. Both layers 3 are extremely thin, and are made of an alloy having a melting point lower than that of substrate 2. Insert 1 is used to achieve liquid phase diffusion bonding of first and second base metals 4 and 5. More precisely, insert 1 is interposed between first base metal 4 and second base metal 5. Then, insert 1 and base metals 4 and 5 are clamped together with a pressure of, for example, 50 bar, and are placed in a atmosphere of a low pressure of about 10^{-4} Torr and heated to the melting point of alloy layers 3 or to a temperature above this melting point but below the melting points of substrate and base metals 4 and 5. Hence, neither the substrate nor base metals melt or be deformed. As the heating proceeds, the atoms of alloy layers 3 diffuse into base metals 4 and 5. When layers 3 cease to exist at all, base metals 4 and 5 are firmly bonded by substrate 2.

Base metals can be made of a metal or an alloy. Substrate 2 is made of a material selected from the group consisting of Fe, Ni, Cu, Ti, a Fe-based alloy, a Ni-based alloy, a Cu-based alloy and a Ti-based alloy. Of these materials, the most workable, strongest after working, and most ductile is cold-rolled into a foil. Since substrate 2 is made of such material, the bonding of base metals 4 and

5 can be sufficiently strong even if substrate 2 remains between the base metals 4 and 5. When substrate 2 is as mechanically strong as, or mechanically stronger than, base metals 4 and 5, the combined structure made up of substrate 2 and base metals 4 and 5 does not broken at substrate 2 when a tensile stress is applied on this structure. This also ensures a sufficiently firm bonding of the base metals. Further, when substrate 2 is as strong as, or stronger than base metals 4 and 5, insert 1 can be strong enough to be interposed between base metals 4 and 5 without being broken. There will arise no practical problem even if bonding alloy layers 3 are not so strong mechanically.

It is desirable that substrate 2 be 5 to 500 μm thick, for some reasons. First, it is difficult to manufacture a foil having a thickness less than 5 μm . Secondly, such a thin foil, even if obtained, is hard to handle. Thirdly, if substrate 2 has a thickness over 500 μm , insert 2 will be too thick to successfully accomplish liquid phase diffusion bonding of base metals whose joining surfaces are uneven. It is more desirable that substrate 2 be 5 to 300 μm . This is because substrate 2, if having a thickness within this range, can be more easily manufactured and handled. As described above, substrate 2 is made by cold rolling. Hence, it has smooth surfaces, and its surface regions are formed of small crystals. Therefore, the atoms of both metal layers 3 can easily diffuse into substrate 2.

No conventional inserts for liquid phase diffusion bonding comprise a substrate. Hence, when two base metals are bonded by using any conventional insert, atoms of one base metal, which may adversely affect the crystal structure of the other base metal, can diffuse into the other base metal. This undesirable phenomenon does not occur when the insert of this invention is used since the insert comprises substrate 2 whose composition and thickness have been adjusted.

Bonding alloy layers 3 are made of a Ni-P alloy, an Ni-B alloy, a Ni-Si alloy, a Ni-Si-B alloy, a Cu-Mn-Ni alloy, a Cu-Zn alloy, a Ag-Ti-Cu alloy or a Cu-Ti alloy. All these alloys have relatively low melting points, ranging from 800 to 1140°C, and can thus easily achieve liquid phase diffusion bonding. In other words, the atoms of these alloy can easily diffuse into substrate 2 and base metals 4 and 5. Since bonding alloy layers 3 are formed on both major surfaces of substrate 2 by plating, they can be extremely thin. Their thickness is preferably 5 to 120 μm . If their thickness is less than 5 μm , layers 3 fail to fasten base metals 4 and 5 at the entire joining surfaces thereof since base metals 4 and 5 have a surface roughness of about 5 μm . Conversely, if the thickness of layers 3 is over 120 μm , it takes a long time for the atoms of layers 3 to diffuse into substrate 2 and base metals 4 and 5,

thereby reducing the efficiency of liquid phase diffusion bonding. More preferable thickness of bonding alloy layers 3 is 5 to 60 μm . Still more preferable thickness is 5 to 20 μm . The liquid phase diffusion bonding can be accomplished in a relatively short time if bonding alloy layers 3 have a thickness falling within any of these ranges.

It is desirable that a difference between the melting point of alloy layers 3 and that of base metals 4 and 5 be at least 200°C. It is also preferable that a difference between the melting point of substrate 2 and that of layers 3 be at least 100°C. Otherwise substrate 2 and base metals 4 and 5 would be deformed in some cases when they are heated to a temperature higher than the melting point of layers 3.

When base metals 4 and 5 are made of the same material (e.g., carbon steel), it would be advisable that both bonding alloy layers 3 be made of this material. In this case, both layers 3 can be simultaneously formed by electroplating on the both major surfaces of substrate 2. Since base metals 4 and 5 are made of the same material, insert 1 can serve to firmly join base metals 4 and 5.

On the other hand, when base metals 4 and 5 are made of different materials, alloy layers 3 of different materials which can well be bonded to the materials of base metals 4 and 5, respectively, are formed on the major surfaces of substrate 2. In this case, too, layers 3 can serve to strongly bond base metals 4 and 5. Therefore, the insert of this invention can bond two base metals made of different materials, strongly unlike the conventional inserts for liquid phase diffusion bonding.

Fig. 3 is a cross-sectional view of an insert 10 according to a second embodiment of the invention. Fig. 3 shows two base metals 8 and 9 joined by the insert 10 interposed between them. As is shown in Fig. 3, insert 10 comprises thin substrate 2 made by cold-rolling, and one bonding alloy layer 3 formed by plating on one surface of substrate 2. This insert 10 can be used when base metals 8 and 9 are made of, for example, stainless steel and carbon steel, respectively. Substrate 2 is made of carbon steel.

Layer 3 is formed on the lower surface of substrate 2, so as to contact base metal 8. Since substrate 2 and base metal 9 are made of the same material, they can be join by direct diffusion bonding. Base metal 8 and substrate 2, which are made of different materials, are readily bonded by means of liquid phase diffusion bonding, as the atoms of alloy layer 3 diffuse into substrate 2 and base metal 8. Therefore, substrate 2 can strongly bond base metals 8 and 9 together.

In either the first or the second embodiment, each bonding alloy layer 3 can be formed by

various plating methods, such as electroplating, hot dipping, nonelectrode plating, sputtering, vacuum plating and ion plating.

Several examples of the invention will now be described.

Example 1

A Ni foil having a thickness of 100 μm was made by rolling. Two layers of Ni-11wt%P alloy, having a thickness of 20 μm , were formed on the both surfaces of the Ni foil, respectively, by the known electroplating process. Thus was obtained an insert. This insert was interposed between two plates of Fe-18wt%Cr-18wt%Ni alloy. The two plate-like base metals and the insert were placed within a furnace filled with Ar gas. They are then heated at 1000°C for one hour, while a pressure of 100 bar was being applied on the insert by pressing both plates onto the insert. As a result, a combined structure was obtained. It was observed that the atoms of Ni-11wt% P alloy had diffused into the Ni foil and both base metals, uniformly over the entire joining interface of the foil and base metals. The combined structure was put to a tensile strength test. It was broken, not at the joining interface of the foil and base metals, but at a portion of one of the base metals.

Example 2

A Ni foil having a thickness of 50 μm was made. Two layers of Ni-4.0wt%B alloy, having a thickness of 5 μm , were formed on the both surfaces of the Ni foil, respectively, by magnetron sputtering process, thus obtaining insert. The magnetron sputtering process was performed in a Ar gas atmosphere of 10^{-5} Torr, by supplying a DC current of 500 to 1000 V to the Ni foil for 30 minutes. This insert was interposed between two block-like base metals of Inconel 718 (an Ni-Cr-Fe alloy), each being 500 mm wide, 500 mm long, and 100 mm thick. The base metals and the insert were placed within a furnace in which a reduced pressure of 10^{-4} Torr was maintained. They are then heated at 1150°C for 30 minutes, while a pressure of 50 bar was being applied on the insert by pressing both base metals onto the insert. As a result, a combined structure was obtained. It was observed that both base metals were as firmly bonded as the plate-like base metals were in Example 1. The combined structure was put to a tensile strength test. It was broken, not at the joining interface of the foil and base metals, but at a portion of one of the base metals.

Example 3

An Inconel 713C foil having a thickness of 100 μm was made. Two layers of Ni-7.0wt%Si-2.0wt%B alloy, having a thickness of 5 μm , were formed on the surfaces of the Inconel 713C foil, respectively, by magnetron sputtering process, thereby obtaining insert. The magnetron sputtering process was performed under the same conditions as in Example 2. This insert was interposed between two block-like base metals of Inconel 713C, each being 500 mm wide, 500 mm long, and 200 mm thick. The base metals and the insert were placed within a furnace in which a reduced pressure of 10^{-5} Torr was maintained. They are then heated at 1150°C for 6 hours, while a pressure of 50 bar was being applied on the insert by pressing both base metals onto the insert. As a result, a combined structure was obtained. It was observed that the joining interface of both blocks had the same crystal structure of any other portions of the base metals.

Example 4

A Cu foil having a thickness of 50 μm was made by rolling. One layer of Cu-35wt%Mn-9.0wt%Ni alloy, having a thickness of 20 μm , were formed on one surface of the Cu foil by the known hot dipping process, thus obtaining an insert. The insert was interposed between two base metals which are a Cu plate and a carbon steel plate, respectively, with the layer of Cu-35wt%Mn-9.0wt%Ni alloy contacting the carbon steel plate. The base metals and the insert were placed within a furnace in which a reduced pressure of 10^{-5} Torr was maintained. They are then heated at 1000°C for 30 minutes, while a pressure of 50 bar was being applied on the insert by pressing both base metals onto the insert. As a result, a combined structure was obtained. It was observed that the base metals were as firmly bonded together as in Example 1. The combined structure was put to a tensile strength test. It was broken, not at the joining interface of the foil and base metals, but at a portion of one of the base metals.

Example 5

A Cu foil having a thickness of 50 μm was made by rolling. A layer of Cu-32.5wt%Zn alloy and another layer of Ni-11wt%P alloy, both having a thickness of 20 μm , were formed on two surfaces of the Cu foil, respectively, by the known electroplating process. Thus an insert was obtained. The insert was interposed between two base met-

als which are a Cu plate and a carbon steel plate, respectively with the Cu-32.5wt%Zn alloy layer contacting the Cu plate, and with the Ni-11wt%P alloy layer contacting the carbon steel plate. The base metals and the insert were placed within a furnace in which a reduced pressure of 10^{-5} Torr was maintained. They are then heated at 1000°C for 30 minutes, while a pressure of 50 bar was being applied on the insert by pressing both base metals onto the insert. As a result, a combined structure was obtained. It was observed that the base metals were as firmly bonded together as in Example 4. The combined structure was put to a tensile strength test. It was broken, not at the joining interface of the foil and base metals, but at a portion of the Cu base metal.

Example 6

A Cu foil having a thickness of 300 μm was made by rolling. A layer of Ag-2wt%Ti-30wt%Cu alloy, having a thickness of 5 μm , was formed on one surface of the Cu foil by magnetron sputtering process under the same conditions as in Example 2. Further, another layer of Ni-11wt%P alloy, having a thickness of 10 μm , was formed on the other surface of the Cu foil, by the known nonelectrode plating process. Thus was obtained an insert. The insert was interposed between two base metals which are a Ti plate and a carbon steel plate, respectively with the Ag-2wt%Ti-30wt%Cu alloy layer contacting the Ti plate, and with the Ni-11wt%P alloy layer contacting the carbon steel plate. The base metals and the insert were placed within a furnace in which a reduced pressure of 10^{-5} Torr was maintained. They are then heated at 950°C for 3 hours, while a pressure of 50 bar was being applied on the insert by pressing both base metals onto the insert. As a result, a combined structure was obtained. It was observed that the base metals were as firmly bonded together as in Example 1. The combined structure was put to a tensile strength test. It was broken, not at the joining interface of the foil and base metals, but at a portion of the Ti base metal.

Example 7

A Ni foil having a thickness of 50 μm was made by rolling. Two layers of 72wt%Cu-28wt%Ti alloy, having a thickness of 5 μm , were formed on the two major surfaces of the Ni foil, respectively, by magnetron sputtering process the same conditions as in Example 2, thus obtaining an insert. The insert was interposed between two base metals which are a Ti plate and a carbon steel plate.

The base metals and the insert were placed within a furnace in which a reduced pressure of 10^{-5} Torr was maintained. They are then heated at 950°C for 3 hours, while a pressure of 50 bar was being applied on the insert by pressing both base metals onto the insert. As a result, a combined structure was obtained. It was observed that the base metals were as firmly bonded together as in Example 6. The combined structure was put to a tensile strength test. It was broken, not at the joining interface of the foil and base metals, but at a portion of the Ti base metal.

The present invention is not limited to the embodiments described above. A variety of changes or modifications can be made without departing from the spirit and scope of the invention.

Claims

1. An insert to be interposed between first and second base metals each made of a metal or an alloy for joining the first and second base metals (4, 5) by liquid phase diffusion bonding, said insert characterized by comprising:

a thin substrate (2) made of a material selected from the group consisting of Fe, Ni, Cu, Ti, a Fe-based alloy, a Ni-based alloy, a Cu-based alloy and a Ti-based alloy; and

two bonding alloy layers (3) formed by plating on the two major surfaces of said substrate, respectively, and having a melting point lower than that of the first and second base metals, the atoms of said bonding alloy layers diffusing into said substrate (2) and said first and second base metals, thereby joining said first and second base metals by liquid diffusion bonding, when the insert is interposed between said first and second base metals (4, 5), and said insert and said first and second base metals are then heated to a temperature not lower than the melting point of said bonding alloy layers.

2. The insert according to claim 1, characterized in that said substrate (2) has a thickness of 5 to 500 μm .

3. The insert according to claim 1 or 2, characterized in that said substrate (2) has a thickness of 5 to 300 μm .

4. The insert according to any of claim 1 to 3, characterized in that that said substrate (2) is made by rolling.

5. The insert according to any of claims 1 to 4, characterized in that said bonding alloy layers (3) have a thickness of 5 to 120 μm .

6. The insert according to any of claims 1 to 5, characterized in that said bonding alloy layers (3) have a thickness of 5 to 60 μm .

7. The insert according to any of claims 1 to 6, characterized in that said bonding alloy layers (3) have a thickness of 5 to 20 μm .

8. The insert according to any of claims 1 to 7, characterized in that said plating includes electroplating, vacuum plating, hot dipping, nonelectrode plating, sputtering and ion plating.

9. The insert according to any of claims 1 to 8, characterized in that said bonding alloy layers (3) are made of a material selected from the group consisting of a Ni-based alloy, a Cu-based alloy, and a Ti-based alloy.

10. The insert according to any of claims 1 to 9, characterized in that said substrate (2) has a melting point higher than that of said bonding alloy layers (3) by 100°C or more.

11. The insert according to any of claims 1 to 10, characterized in that said bonding alloy layers (3) have a melting point lower than that of said first and second base metals (4, 5) by 200°C or more.

12. An insert to be interposed between first and second base metals (9, 8) each made of a metal or an alloy for joining the first and second base metals by liquid diffusion bonding, said insert characterized by comprising:

a thin substrate (2) made of the same material as said first base metal or a material containing an element which is the main component of said first base metal (9), said material being selected from the group consisting of Fe, Ni, Cu, Ti, a Fe-based alloy, a Ni-based alloy, a Cu-based alloy and a Ti-based alloy; and

one bonding alloy layer (3) formed by plating a major surface of said substrate (2), which is to contact said second base metal (8), and having a melting point lower than those of said substrate and said second base metal (8), the atoms of said substrate diffusing into said first base metal (9), and the atoms of said bonding alloy layer (3) diffusing into said substrate (2) and said second base metal (8), thereby joining said first and second bodies (9, 8) by liquid phase diffusion bonding, when the insert is interposed between said first and second base metals (9, 8), and said insert and said first and second base metals (9, 8) are then heated to the melting point of said bonding alloy layers or to a higher temperature.

13. The insert according to claim 12, characterized in that said substrate has a thickness of 5 to 500 μm .

14. The insert according to 12 or 13, characterized in that said substrate has a thickness of 5 to 300 μm .

15. The insert according to any of claims 12 to 14, characterized in that said substrate (2) is made by rolling.

16. The insert according to any of claims 12 to 15, characterized in that said bonding alloy layer (3) has a thickness of 5 to 120 μm .

17. The insert according to any of claims 12 to 16, characterized in that said bonding alloy layer (3) has a thickness of 5 to 60 μm .

18. The insert according to any of claims 12 to 17, characterized in that said bonding alloy layer (3) has a thickness of 5 to 20 μm .

19. The insert according to any of claims 12 to 18, characterized in that said plating includes electroplating, vacuum plating, hot dipping, nonelectrode plating, sputtering and ion plating.

20. The insert according to any of claims 12 to 19, characterized in that said bonding alloy layer (3) is made of a material selected from the group consisting of a Ni-based alloy, a Cu-based alloy and a Ti-based alloy.

21. The insert according to any of claims 12 to 20, characterized in that said substrate (2) has a melting point higher than that of said bonding alloy layer (3) by 100°C or more.

22. The insert according to any of claims 12 to 21, characterized in that said bonding alloy layer (3) has a melting point lower than that of said first and second base metals (8,9) by 200°C or more.

FIG. 1

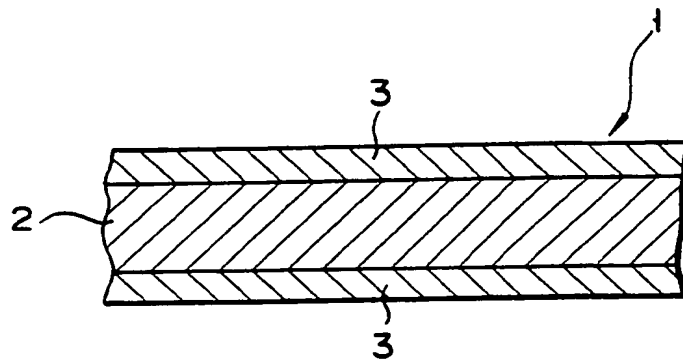


FIG. 2

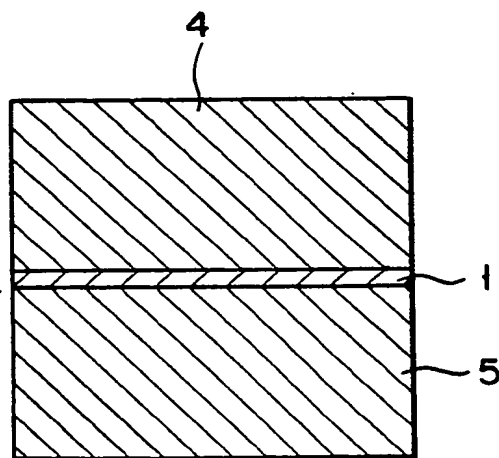


FIG. 3

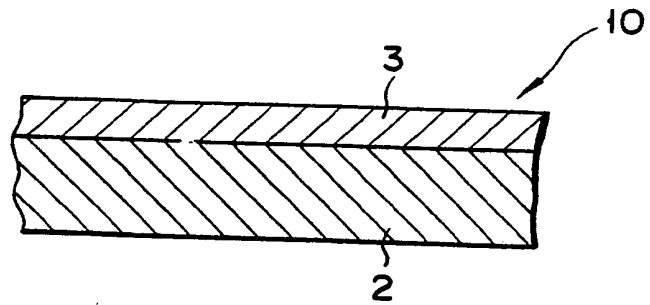
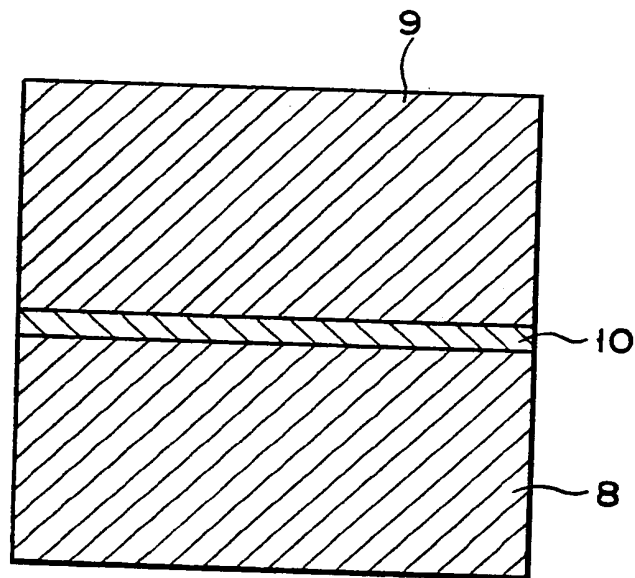


FIG. 4





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ⁴)
X	FR-A-2 147 512 (O.N.E.R.A.) * Claims *	1-22	B 23 K 35/02 B 23 K 35/30 B 23 K 35/32
X	--- US-A-4 029 479 (E.G. PARKER) * Whole document *	1-22	
A	--- EP-A-0 038 584 (BBC BROWN, BOVERI & CIE)		
A	--- US-A-4 340 650 (S. PATTANAIK et al.)		
A	--- US-A-4 034 906 (C.E. CARLSON et al.)		
A	--- US-A-3 859 144 (M. BASCHE et al.)		TECHNICAL FIELDS SEARCHED (Int. Cl. ⁴) B 23 K
A,D	--- US-A-3 678 570 (D.F. PAULONIS et al.) -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13-10-1987	Examiner MOLLET G.H.J.
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